A HIGH RESOLUTION GLOBAL OCEAN MODEL with VARIABLE FORCING of WIND, HEAT, & FRESHWATER: I) INITIAL EVALUATION

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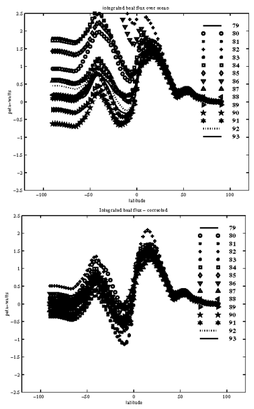
Goal: Understand ocean's low freq. variability

Conclusions in Red



Model Simulation Details

(Semtner & Chervin '92, Stammer, et al. '96, Tokmakian, '96)

- 1/4°avg. Semtner/Chervin Primitive Eq. OGCM
- Parallel Ocean Climate Model POCM-vers 4C
- Forced with ECMWF reanalysis (79-93) + oper. (94-96)

--> heat, freshwater, wind stress - varying daily (river out flow included)

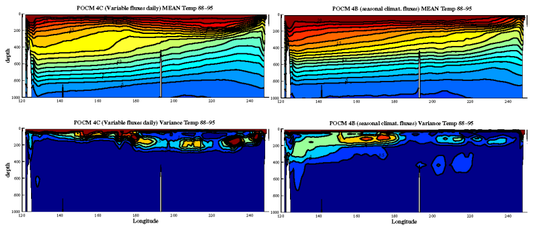
ECMWF surface forcing fields of total heat flux and E-P adju sted between +/- 20°N to conserve the net annual flux of heat and freshwater into the model. The plots to the right show the imbalance of the annual heat flux for the years 1979-1993, uncorrected (top) and corrected (bottom).

Model output avail. see www.scivis.nps.navy.mil/~rtt

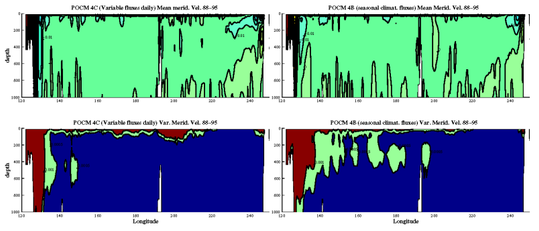
24°N: Example of a section with different surface forcing

Two simulations of the same model with different surface for cing are shown below. The left panel of each pair is run 4C, with variable surface for cing and the panel to the right is with monthly climatological forcing.(4B) *The comparison shows that the new forcing has changed both the mean and the location of the variability in both th e temperature and meridional velocity fields. Future analysis will attempt to explain these diffe rences; especially below the surface.*

Pacific

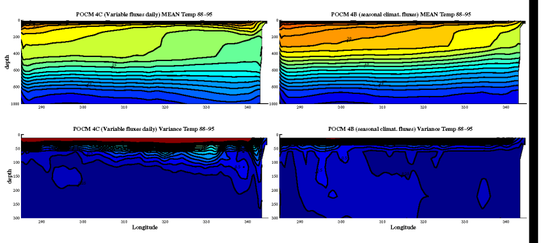


The mean temperature over 8 years has been modified with the use of variable surface fluxes and is cooler than when climatological fluxes are used. Observations (*Bryden, et al,'91*) fall some where in between the two simulations. Contours are 1°C.

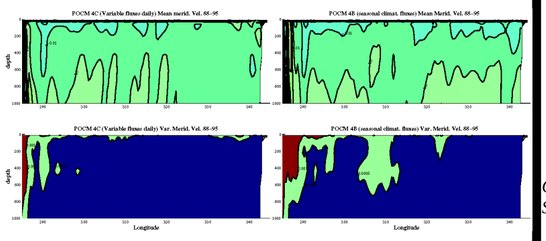


In the mean, the two velocity sections are very similar. Run 4C, with variable forcing produces a narrower Kuroshio current. Contours are 0.05 cm^2/s^2.

Atlantic



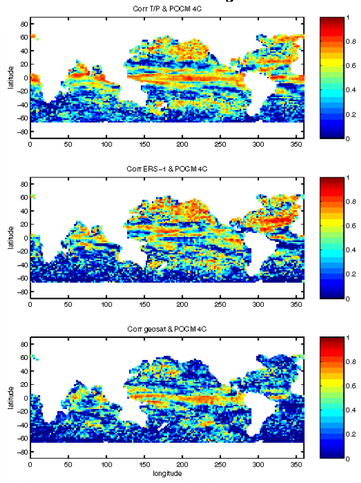
The temperature field shows higher variability down to 200 meters with variable surface forcing. In the mean, the model with variable forcing is cooler (top 500 m) than run 4B; & resembles observations better (*Roemmich & Wunsch, '85*). Contours are 1°C.



The variability in the velocity of the Gulf Stream is reduced in the 4C run. Contours are 0.05 cm^2/s^2.

Evaluation of Model with Observational Data

Altimetry

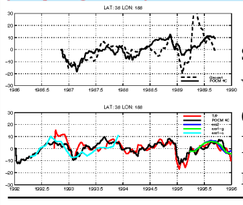


T/P & Model Corr. over Oct93 to 1996. Correlations reflect similar patterns to the corr. with tide gauges to right. Reflects the high quality of momentum forcing.

ERS-1 & Model Corr. over Apr. 92 to 1995. Note the improvement in the correlations in the Atlantic over T/P correlation map.

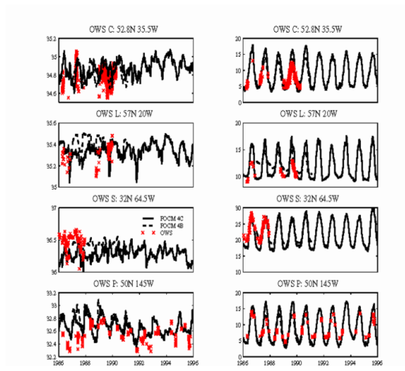
Geosat & Model Corr. over Oct. 86 to Oct. 88.

Model output and altimeter data from the NASA pathfinder data set (*Koblinsky, et al. Nasa/ Goddard*) have been gridded into monthly, 2°x 2°, bins fields. Corr. coeff. computed between data and the model. *The model can be used to chk the consistency between the altimeter data sets; thus, with careful analysis of the areas of high corr., insight can be gained about the low freq. signal of the ocean.*



Shows the time series of the model data with the various satellite data in the north west Pacific. In general, model & all data agree.

Ocean Weather Stations

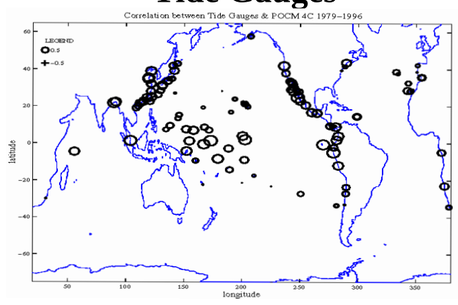


OWS C,L,S courtesy of ICES (International Council for the Ex pl. of the Sea : www.ices.inst.dk/ocean/ocean.htm. OWS P courtesy of H. Freeland

Comparisons of temperature (right) and salinity (left) to 4 ocean weather station data (in red). Model averaged to about 60km around OWS locations (avg of top 30m).

The amplitude of the annual cycle maybe too large in POCM temp.

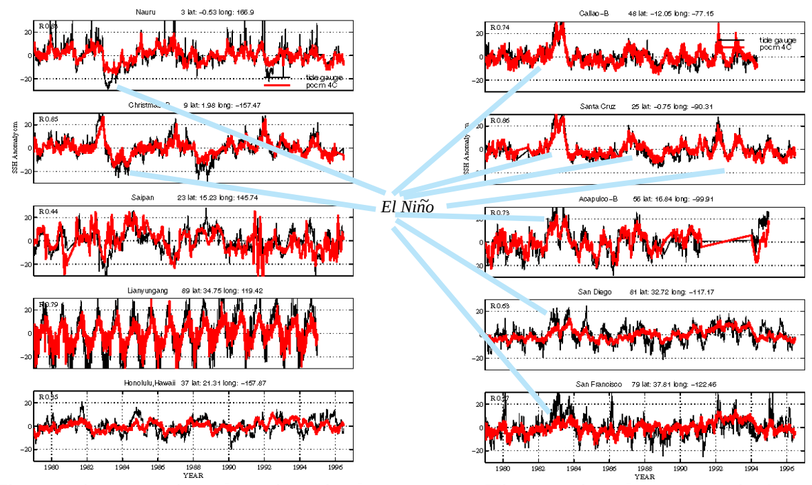
Tide Gauges



Correlations between tide gauge measurements and model estimates of SSH anomalies.

Excellent correlations can be found in the tropics and above 30°N. Lack of high correlations in the Southern Ocean is partly due to inadequate winds and to the very turbulent character of the flow.

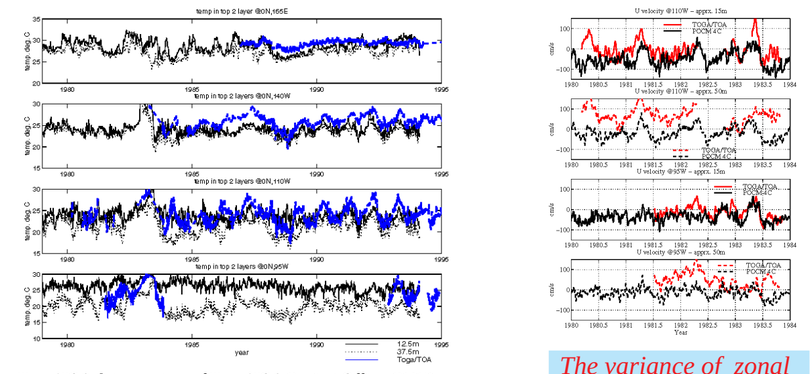
Tide gauge data from the Joint Archive for Sea Level (Univ. Hawaii & NODC) http://uhslc.soest.hawaii.edu.



Time series at various locations in the Pacific. *Red:* Tide Gauge, *Black:* POCM 4C

Time series along America's West Coast.

TOGA/TOA



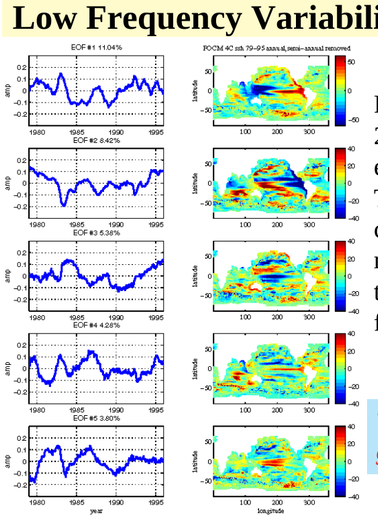
Toga/TOA data courtesy of Toga/TOA Project Office, PMEL; Dr. M. McPhaden Director

Time series of the top 2 levels of temperature in POCM 4C (black) as compared to SST as measured by the TOGA/TOA array (blue) at 165°E, 140°W, 110°W and 95°W.

The increase in temperature at 140,110, & 95°W for the '82 El Nino for the 2 levels is very prominent.

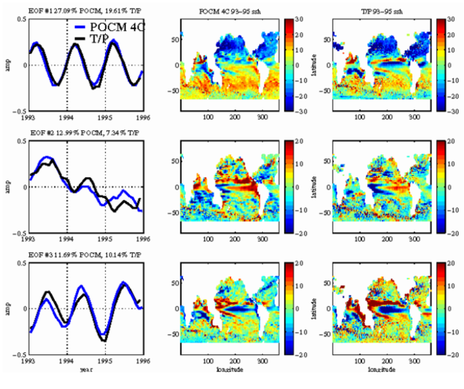
The variance of zonal velocity at 2 locations in the tropical Pacific are simulated well, as compared to TOGA/ TOA. The model's mean velocity is too weak @ 50m depth.

Low Frequency Variability

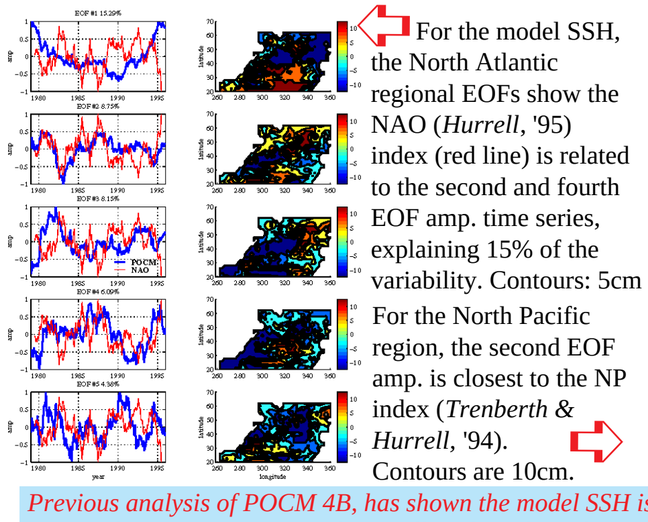


Empirical Orthogonal Functions were formed from 2°x2° binned model SSH for each 3-day field over 17 years. The annual and semi-annual cycles were removed and the resulting eof patterns and amp time series are shown at left for the first 5 EOFs.

The predominant signal globally is the ENSO signal.

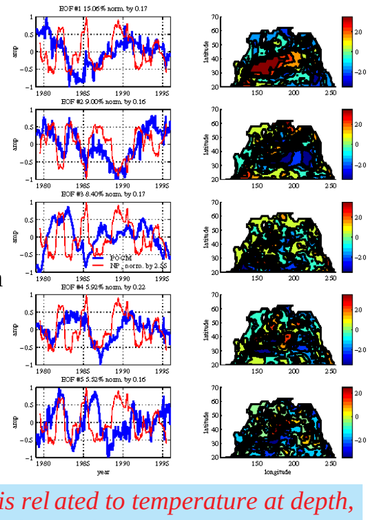


Comparisons of EOFs of 3 years of T/P altimeter data and model SSH anomalies show similar patterns (includes annual).



For the model SSH, the North Atlantic regional EOFs show the NAO (*Hurrell*, '95) index (red line) is related to the second and fourth EOF amp. time series, explaining 15% of the variability. Contours: 5cm

For the North Pacific region, the second EOF amp. is closest to the NP index (*Trenberth & Hurrell*, '94). Contours are 10cm.



Previous analysis of POCM 4B, has shown the model SSH is rel ated to temperature at depth, in some locations. Future analysis will explore this relatio nship in this new simulation.

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